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# **Radiological Safety Handbook**





UNITED STATES DEPARTMENT OF AGRICULTURE

RADIOLOGICAL SAFETY

HANDBOOK

General Rules Governing the Use of  
Radioactive Materials and Radiation  
Equipment in the Department of Agriculture

July 1, 1959



The approved citation of this Handbook is "RSH." Thus RSH 2.1 refers to that part of the Handbook headed "Receipt of Materials" under Section 2. RSH Supp 20.102 refers to that part of the Handbook headed "Permissible levels of radiation in unrestricted areas" on Page 1 of the Supplement.



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## GENERAL RULES GOVERNING THE USE OF RADIOACTIVE MATERIALS AND RADIATION EQUIPMENT IN THE DEPARTMENT OF AGRICULTURE

### SECTION 1 - GENERAL

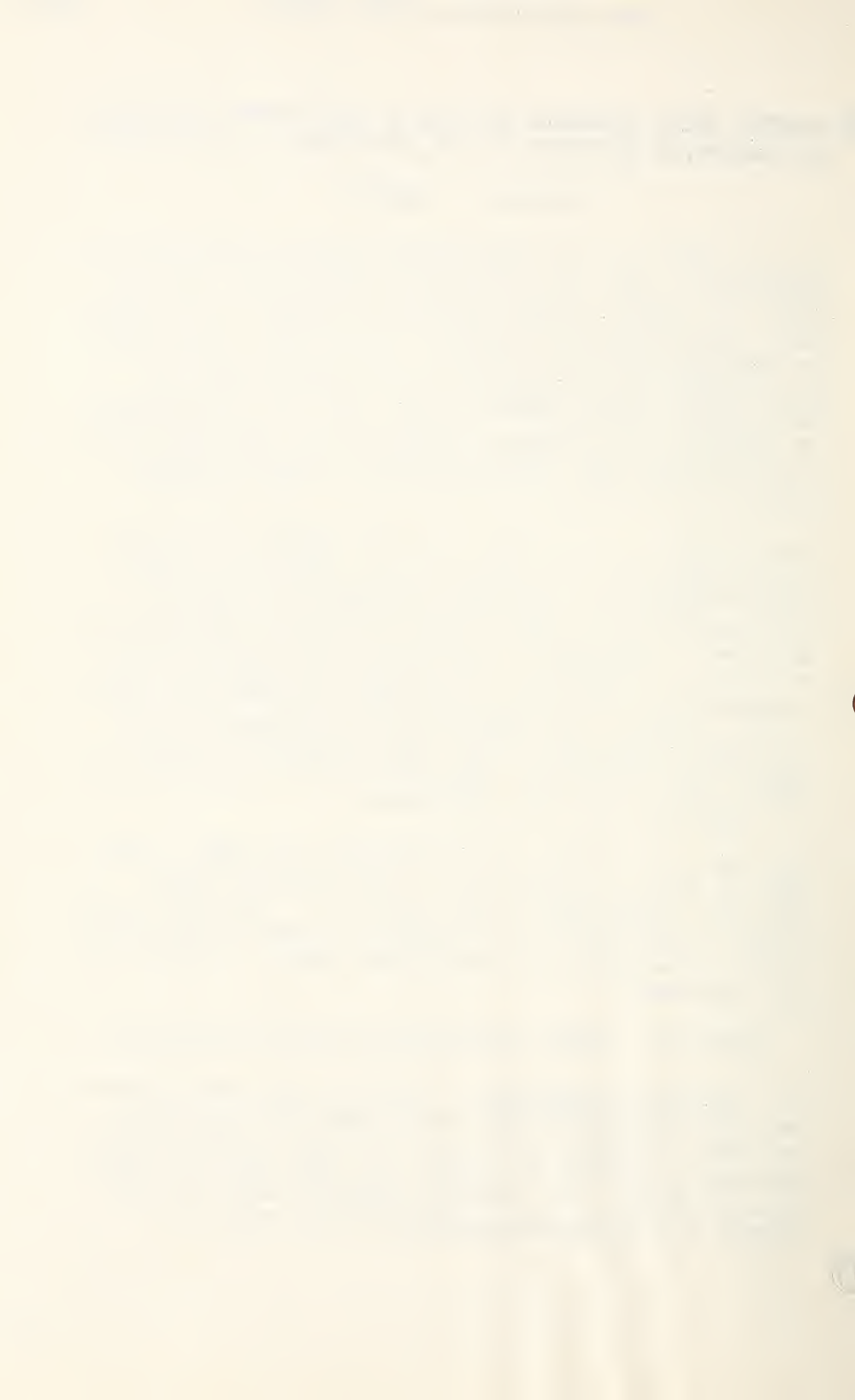
1.1 In order that the Radiological Safety Committee may effectively carry out the duties assigned by 1 AR 376 - 386.2, the general rules which follow apply to all USDA employees working with radioactive materials or equipment of potential radiation hazard. These rules, as well as any requirements prescribed by the Committee or the Radiological Safety Officer (RSO), are for the purposes of reducing the hazards of exposure and contamination and of minimizing legal risks associated with the presence and/or use of radioactive materials on USDA premises.

The attention of all USDA employees engaged in or concerned with the use, disposition or transfer of radioactive materials or radiation equipment is directed to the regulations of other Federal and State agencies which may be applicable. Some of these regulations are referred to in parts of this manual and others will be incorporated from time to time where necessary and practicable; however, the absence from this manual of any applicable regulation of any other Federal or State agency does not relieve employees of the responsibility for complying with such regulations.

The approved citation of this Handbook is "RSH." Thus RSH 2.1 refers to that part of the Handbook headed "Receipt of Materials" under Section 2. RSH Supp 20.102 refers to that part of the Handbook headed "Permissible levels of radiation in unrestricted areas" on Page I of the Supplement.

### SECTION 2 - RULES CONCERNING RADIOACTIVE MATERIALS

2.1 Receipt of Materials. Receipt of all radioactive materials, regardless of source, shall be reported to the RSO on OA Form 2, Report of Receipt of Radioactive Materials, (Exhibit A), within two days after the shipment is opened. All incoming shipments shall be consigned to individuals designated by the Committee.



2.2 Reports. In addition to specific reports required by these rules, special reports of monitoring, survey and exposure may be required by the RSO. Such special reports will be scheduled by the RSO at the time of, or prior to, initiation of the work. Reporting requirements may be modified only by written authorization of the RSO.

2.3 Waste Disposal. Waste disposal must be in accordance with the requirements of 10 CFR 20.303, 20.304 or 20.305 (see Supplement, page 3 ) unless written approval for exception is obtained from the RSO. Any departure from the requirements of 10 CFR 20 must be covered by specific amendment to the license approved by the AEC Civilian Extension, Licensing and Regulation, (10 CFR 20.302). Methods given in the several Handbooks of the National Committee (see 7.2 below) can be the basis for application for exemption. Such application must be made through the Committee. Waste disposal reports on OA Form 3, Radioactive Waste Disposal Report, (Exhibit B), must be completed in detail, i.e., as to quantity, form, dates and procedure, and submitted promptly to the RSO.

2.4 Transfers or Exchanges. Transfer or exchange of radioisotopes or labeled materials between any Department employees working under projects approved by the Committee must be reported immediately to the RSO, giving complete information on the projects, isotope and quantity involved. Where such transfer or exchange will involve use of common carrier, prior approval of the RSO is required. The application for such approval must clearly indicate that the shipment will comply with the restrictions imposed by Postal Regulations and the ICC. Instructions as to packaging, shielding and labeling as well as any required labels will be furnished by the RSO. The transfer to or exchange of radioisotopes or labeled materials with any person not in the employ of the Department without prior approval of the Committee is prohibited.

2.5 Changes in Work Plan. Proposed changes in a plan of work involving use of radioisotopes, e.g. total and/or specific activity, location, etc., which might



affect the established safety measures must be submitted to the Committee.

2.6 Rules for Special Projects. Specific rules and regulations for each application, if required, may be imposed by the RSO.

2.7 Radiation Levels in Unrestricted Areas. Without written authorization from the Committee, radiation levels in unrestricted areas (e.g. corridors near storage areas or offices adjacent to x-ray laboratories) may not exceed 2 millirem per hour.

2.8 Inspection. Inspection of projects and facilities will be made by the RSO and/or Committee members as considered necessary.

2.9 Employee Statement. Employees who work in cooperation with other Federal, State or private agencies and whose duties involve the handling, use or exposure to radioisotopes are required to have Committee approval to engage in such work. Requests for such approval shall be made in writing to the Committee through the RSO and shall include:

- a. a statement acknowledging receipt of these rules and agreement to comply therewith as well as with such other rules and requirements as may be prescribed by the Committee and/or the RSO.
- b. a statement of the nature and extent of the employee's participation in the project, and,
- c. a statement, or copy, of the rules, safety measures and exposure records prescribed by the supervising agency.

In addition, employees working in the facilities of or under the supervision of another Federal, State or private agency shall submit as a part of their application for Committee approval evidence of the endorsement or approval of the proposed work by appropriate authority of the institution involved.







## SECTION 3 - RULES AFFECTING PERSONNEL

3.1 Maximum Permissible Exposure. The maximum permissible exposure as defined by 10 CFR 20.101 (See Supplement, Page 1) will be rigidly applied. Workers in restricted areas are permitted the exposure given in the table below.

PERMISSIBLE WEEKLY DOSE

Conditions of exposure		Dose in critical organs (mrem)			
Parts of body	Radiation	Skin, at basal layer of epidermis	Blood forming organs	Gonads	Lens of eye
Whole body.....	Any radiation with half-value-layer greater than 1 mm of soft tissue.	1 600	1 300	1 300	1 300
Whole body.....	Any radiation with half-value-layer less than 1 mm of soft tissue.	1, 500	300	300	300
Hands and forearms or feet and ankles or head and neck.	Any radiation.....	1 500	-----	-----	-----

<sup>1</sup> For exposures of the whole body to X or gamma rays up to 3 mev, this condition may be assumed to be met if the "air dose" does not exceed 300 mr, provided the dose to the gonads does not exceed 300 mrem. "Air dose" means that the dose is measured by an appropriate instrument in air in the region of highest dosage rate to be occupied by an individual, without the presence of the human body or other absorbing and scattering material.

<sup>2</sup> Exposure of these limited portions of the body under these conditions does not alter the total weekly dose of 300 mrem permitted to the bloodforming organs in the main portion of the body, to the gonads, or to the lens of the eye.

Certain exemptions are possible under Federal Code but will be allowed only after consideration of written application for exemption from the limits given above.

Note: For a 40-hour week the hourly rate MPE is 7.5 mrep.

3.2 Personnel Exposure Measuring Devices. Department personnel will wear Committee approved film badges and/or other radiation measuring devices as required by the RSO.

3.3 Personnel Exposure Reports. All workers will submit semiannual summary reports of exposure as indicated by the device(s) used except:

- a. that any exposure in excess of 50 mr/week will be promptly reported to the RSO in writing with explanation of conditions and remedial measures.



- b. immediate report will be made to RSO by telegraph or telephone of any exposure in excess of the MPE (300 mr/wk) with description of circumstances and remedial measures taken as well as certification of suspension of exposure of personnel involved in accordance with 10 CFR 20.105, (See Supplement, Page 2 ).

The RSO may modify the reporting requirements to fit the needs of the project.

3.4 Body Protection. Personnel will wear protective clothing, respirators, shoe covers, etc., as directed by the RSO.

3.5 Handling of Food. No food will be stored, prepared or eaten in areas in which radioisotopes are stored or used.

3.6 Smoking. Smoking will not be allowed in an intermediate or higher level area or, regardless of level, while handling active materials.

3.7 Hands and Clothing. Hands are to be thoroughly washed before eating, smoking, applying cosmetics or leaving work. Employees must acquire the habit of checking hands and clothing with a suitable monitor before eating or leaving work. Shoes must be changed or checked when leaving an intermediate or higher level area.

3.8 Training of Auxiliary Personnel. Protective, cleaning and maintenance personnel must be indoctrinated as to the meaning of radiation warning signs and fully instructed as to safe practices in their work.

3.9 Qualification of Personnel. Employees will not be authorized to work with radioisotopes at tracer or higher level unless they have successfully completed formal training equivalent to the Oak Ridge Institute for Nuclear Studies Course in Basic Techniques or can document progressive laboratory experience in this work under qualified supervision. The Committee must approve the qualifications of all proposed users of radioactive materials.



## SECTION 4 - LABORATORY RULES

4.1 General. Safety in a laboratory using radioisotopes requires vigorous and careful observance of normal laboratory safety requirements, their common sense extension to fit the special case of radioactivity, and the further important requirement that each individual be competent and responsible. From the standpoint of successful application of radioisotopes to research, technical contamination (low level contamination of facilities and equipment) can invalidate months of research. Such contamination is many times smaller than the levels based on health considerations alone so that procedures and facilities designed for minimizing and controlling technical contamination will provide ample personnel protection.

The safe use of radioactive materials in the laboratory is dependent upon the use of proper facilities and equipment, the establishment of good housekeeping and work habits, the use of protective coverings, manipulative devices and suitable disposal procedures and adequate orientation. In some circumstances it may be necessary to require shields, remote handling and time control.

4.2 Laboratory Facilities. The laboratories in which radioisotopes are to be used should be designed for this use and must be approved by the Committee. It is obviously desirable to restrict such laboratories to this use.

4.3 Hoods. All laboratory operations other than lowest level (e.g. counting sample preparation) should be conducted in approved hood. Operations such as distillations or chemical digestion, in which there is any hazard of explosion, splatter or spillage must be carried out in hoods. Prior to their use all hoods must be approved by the Committee. The following requirements must be met to obtain approval.

- a. Hoods must have individual exhaust systems.
- b. Linear air velocity must be in the range of 50-150 feet/minute.





- c. Hood design must minimize turbulence at hood face.
- d. Exhaust system must provide for the insertion of filters if required.

4.4 Work Surfaces and Floors. Work surfaces and floors in areas (including greenhouses) where isotopes or labeled compounds are used or stored will be treated to decrease retention of contamination. Asphalt or vinyl tile or linoleum is recommended when carefully laid and waxed. Absorbent, waterproofed-backed covering will be used on work surfaces, in trays, etc. when radioactive solutions are handled.

4.5 Trays. Suitable trays will be used where required.

4.6 Volatile Materials. Work involving radioactive material in volatile form must be conducted in a closed system in a hood unless special conditions justify written authorization from the Committee for modification of this requirement.

4.7 Shielding. Auxiliary shielding may be required by the RSO.

4.8 Special Tools. The RSO may require the use of special remote handling tools and equipment.

4.9 Radiation Warnings. Any laboratory, room or other area approved for the use or storage of radioisotopes or radiation sources must have the conventional radiation warning posted at the entrance. Laboratory and greenhouse setups, containers and equipment in which radioisotopes are used must be marked with the conventional symbol in accordance with the requirement of 10 CFR 20.203 (See Supplement, Page 2). Containers (flasks, tubes, beakers, etc.) are not required to be marked if transiently used and the user is present or if the quantity present is equal to or less than the amount shown in 10 CFR 20, Appendix C (See Supplement, Page 6).

4.10 Pipetting. Pipetting of radioactive solutions by mouth is prohibited regardless of the activity concentration.





4.11 Gloves. Rubber gloves must be worn in any situation where solutions of radioactive materials are handled or where contamination by such solutions is possible (e.g. harvesting of fresh plant material, sampling animal carcass or excreta).

4.12 Storage. Quantities of radioactive materials in excess of that needed for transient use and portable sealed sources must be stored in a manner to prevent unauthorized use or removal.

4.13 Transportation Containers. Radioactive materials must be transported in containers which minimize the danger of breakage, spillage and exposure to personnel. Solutions will be placed in double containers. (e.g. volumetric flasks placed in beakers with absorbent liners).

4.14 Transfer of Equipment. Laboratory glassware and other equipment involved in use of radioisotopes may not be removed from the restricted area without specific authorization of the individual responsible. The record must show full and proper decontamination before such removal is authorized.

4.15 Instrumentation. The monitoring instrumentation required will be determined at the time of consideration of the application. The minimum instrumentation acceptable will be a single monitoring instrument suited to the radiation involved.

4.16 Monitoring Requirements. Employees will be expected to monitor (using a suitable instrument) and record in their routine notes the radiation level at significant steps of the operation (e.g. at distillation, volume reduction, crystallization and dilution). Such observations will be required, as specified by the RSO, in reports to the Committee. Special monitoring requirements will be imposed on users of sealed sources and radiation equipment.

4.17 Spills and Contamination. A record must be made of any spill or accident which results in the loss of control of any isotope in the quantity shown in 10 CFR 20, Appendix C (See Supplement, Page 6). A report



must be submitted immediately to the RSO describing the circumstances, giving the radiation levels encountered prior to, during and subsequent to decontamination, together with a description of the decontamination measures employed and the time required. If levels in excess of MPE are encountered, the report must identify personnel, their participation and time involved. Information on decontamination of facilities and personnel is given in Handbook No. 48 (See 7.2 below).

4.18 Contaminated Equipment. Laboratory and other equipment which cannot be decontaminated to a count less than 100 cpm (0.1 mrep) at 1" will be held and treated as waste.

4.19 Contaminated Work Surfaces. Any surface (bench, floor, hood, wall, etc.) showing a count rate as great as 100 cpm (0.1 mrep) at 1" must be decontaminated or treated as waste.

4.20 Contaminated Clothing. Clothing must be monitored and if necessary decontaminated and checked before entering common laundry facilities.

4.21 Contaminated Waste. All contaminated waste must be carefully segregated from uncontaminated waste and placed in labeled containers. The label must be dated and show the isotope and quantity.

## SECTION 5 - FIELD EXPERIMENT RULES

5.1 Definition. A "field" experiment is any experiment in which radioactive material is released into the biosphere (e.g. release of tagged insects, use of labeled soil amendments, use of tracer elements in studies of ground water movement, etc.).

5.2 AEC Approval. All "field" experiments require specific authorization of USAEC, Licensing and Regulation. Application for such authorization, either as a specific license or amendment to the Departmental license, will be made by the Committee. Requests for approval must include the following information in addition to, and as part of, that submitted in the application for approval.



- a. Population. A full description of the distribution of the human population and the live-stock population in and near the experimental area.
- b. Watershed. A detailed statement of the relationship of the experimental area to watersheds from which domestic water supplies are collected including a topographic map of the area if the proximity of such watersheds may constitute a hazard under the conditions of the experiment.
- c. Geology. All information available on the underground strata with reference to the likelihood of movement of water on the fixation of activity by mineral components.
- d. Control. A statement regarding the degree of control which can and will be maintained over the area.

5.3 Committee Approval. In addition to the requirements of 5.2 above, the Committee will require assurance that the following will be complied with before submitting field experiments for AEC approval:

- a. Control of Land. Experiments involving field use of radioelements will be carried out on Federal lands under the immediate control of a Department agency. Where lands under the jurisdiction of another Federal agency are used, the Memorandum of Understanding or other agreement must specifically refer to the use of radioactive materials and indicate approval of the outside agency.

If there are situations where it seems to be essential that land other than that owned or controlled by a Federal agency be used, the RSO must be contacted regarding the matter.

- b. Control of Persons. Plans for the restriction of access to and the marking of the experimental area will be agreed upon by the user and the RSO.



- c. Monitoring. Monitoring requirements will be established by the RSO. Reports of monitoring will be made on QA Form 23, Field and Greenhouse Experiments Monitoring Report, (Exhibit C). No experiment will be undertaken where conditions will not permit the worker to fully complete the monitoring report required.
- d. Crop and Waste. The crop and/or waste from a field experiment will be removed or otherwise disposed of in accordance with procedures approved by the Committee before the experiment is initiated.

## SECTION 6 - RULES CONCERNING SEALED SOURCES

6.1 General. Several types of sealed radiation sources are of interest to Department personnel. Specific rules for handling, monitoring and reporting will be determined for each case by the Committee. Prior approval of the Committee is required for the procurement of all sealed radiation sources whether or not such sources require AEC license.

6.2 Approval. Authorization by the Committee for the procurement of any sealed source will be dependent upon the information furnished in the application. The application must include the following.

- a. General statement of proposed use.
- b. Isotope and total activity required.
- c. Design of source.
- d. Design of shield and manipulative mechanism, if any.
- e. Layout of laboratory or use site with indication of occupancy factor of adjacent rooms.
- f. Operational procedures, including monitoring.
- g. Emergency procedures.







- h. Identification of personnel involved and their qualifications.

6.3 Labeling. The source, container and/or area must be labeled or marked as indicated below.

a. Each container or source holder, including the carrying case if source is portable, must bear a durable label which incorporates the accepted radiation warning symbol.

b. In those cases where the source is covered by AEC license, the label must include identification of the isotope, activity, manufacturer and serial number, and the words "Caution - Radioactive Materials - Unauthorized Persons Stay Away".

c. Storage areas and areas where irradiation devices are used must bear the warning sign given in b above. In the case of radiation devices it may be necessary to establish and maintain tolerance distances, working times and to restrict access.

6.4 Instruction of Personnel. All personnel must be fully instructed as to handling and operational procedures and be fully aware of all restrictions that are imposed.

6.5 Leak Tests. Leak tests shall be performed at intervals of not more than six (6) months. The selection of a testing procedure to be used for a particular sealed source must be based upon demonstrated efficiency in the removal of radioactive contamination from sources of this particular construction and material with special consideration of the radiological hazard to the person performing the test. Prior approval of the Committee must be obtained for all leak test procedures. Evidence must accompany the description of the test proposed to clearly establish that the test procedure has a sensitivity and accuracy which will permit establishing the contamination level set forth below.

a. Performance of Tests. The actual testing may be done by either of the following methods.



(1) Where facilities are considered to be satisfactory and personnel with adequate training and experience are available, the test may be performed by the user or staff members. If this method is selected, the application must include a description of the facilities to be used, identification of the individuals who will perform the testing and a statement of their qualifying experience and training.

(2) Contract with the supplier or qualified commercial service for the testing. In this case the application must include the name and pertinent experience of the firm selected unless such testing is a part of the procurement contract.

(3) Obtain the desired source on a rental basis in which case responsibility for leak testing remains with the manufacturer or supplier.

b. Kinds of Tests. The leak tests described below have been accepted by the AEC for certain sources (when tests were performed by the manufacturer).

(1) Scrub Test. The object to be tested is immersed in a solution which will not attack the material of which the container or source holder is made and which has been demonstrated to be effective in removing the radioisotope involved when the object is scrubbed with a brush under the surface of the liquid. All surfaces of the object are brushed thoroughly under these conditions. The total radioactivity is measured in the residue obtained by the evaporation of the solution.

(2) Immersion Test. The object to be tested is immersed in a solution which will not attack the material of which the container or source holder is made and which, under the conditions of this test, has been demonstrated to be effective in removing the radioisotope involved. The solution is heated to  $50 \pm 5$  degrees centigrade and held at this temperature for eight hours. The total radioactivity is measured in the residue obtained by evaporation of the solution.

(3) Wipe Test. All exposed external surfaces of the object to be tested are wiped thoroughly with a



piece of filter paper of high wet strength and absorption capacity, moistened with a solution which will not attack the material of which the container or source holder is made and which, under the conditions of this test, has been demonstrated to be effective in removing the radioisotope involved. The paper is allowed to dry. Then the radioactivity on the paper is measured.

(4) Cellulose Tape Test. This test is applicable to a device containing a sealed source in a source holder which has an opening through which the radiation emerges. This opening is kept covered for a minimum of seven days with a piece of thin adhesive cellulose tape. The tape is removed carefully and the radioactivity which may have been deposited on its adhesive side is measured.

c. Results and Reports. If the approved test reveals the presence of more than 0.05 microcurie of beta particle or gamma emitting radioactivity, it shall be immediately removed from use for repair or disposal. If the radioactivity is an alpha particle emitter, it must be removed from use if the level is as great as 0.005 microcurie. Results of leak tests must be recorded and reports on the findings submitted to the RSO promptly upon completion.

6.6 Special Requirements for Neutron Soil Moisture Meters. Instruments of this type give gamma fields at one to two feet which are in excess of the MPE rate (greater than 7.5 mr/hr.). Because of the potential hazard in using such instruments, special requirements as set forth below must be met.

a. Committee Approval. Application to the Committee for authorization to use a neutron soil moisture meter must include the following:

(1) A general statement in regard to the major use of the equipment (e.g., follow the effect of tillage practice on moisture movement).

(2) The anticipated schedule of use (e.g., daily observations on 72 sites or once a week readings at four depths on 1020 sites).



(3) The nominal activity of the source and a statement whether or not the equipment desired will include a separate gamma-ray probe.

(4) The identification of all personnel who will be involved in the actual use of the instrument and the individual responsible for maintenance or records.

(5) A description of the storage and security measures to be employed and the proposed method of transporting the equipment in the field.

(6) A statement on the availability and description of monitoring equipment. Procurement of a relatively inexpensive beta - gamma GM-probe type instrument calibrated in mr/hr is recommended. An equivalent instrument must be at hand.

b. Equipment Monitoring and Reporting. Using a GM type gamma survey meter as recommended in a(6) above or an equivalent instrument, the following monitoring data will be recorded and reported at such times as considered necessary by the Committee.

(1) Maximum radiation levels at surface on all sides of the shipping container.

(2) Maximum radiation levels at surface of the carrying case, if provided.

(3) Maximum radiation level at one foot from and at surface (if possible) of the source in the field carrying array (if source is shielded this will be 1 foot from and at surface of shield).

(4) Maximum meter readings at 1 foot from and at surface of unshielded probe (if instrument used does not have adequate range for these measurements, record and report the distance from the unshielded probe at which the maximum scale reading is observed).

(5) Maximum reading at access-tube-ground interface with the source at 1 foot depth.

(6) Film badge observations (for eight hours







continuous exposure) at 1 foot and 3 feet from the source when set up for field carrying.

(7) Radiation level at closest approach to storage area (not to exceed 1 mr/hr.).

c. Personnel Monitoring and Reporting. All personnel concerned with the field use of such equipment will be monitored and reports submitted as indicated below.

(1) Each individual will wear two badges, one at waist and one at ankle.

(2) An additional badge will be worn at ankle of worker handling probe placement (2 badges at ankle and 1 at waist). This will totalize exposure at ankle level for the use period.

(3) The use period will be set by the Committee at the time of approval and initially will not exceed two weeks.

(4) Film badge reports using OA Form 22, Personnel Radiation Exposure Report, (Exhibit D), will be submitted promptly to the RSO on a schedule determined at the time of approval and in accordance with instructions furnished by the RSO.

(5) The responsible individual will maintain as a permanent record for each user a "use log" with the following entries:

- (a) name
- (b) date
- (c) hours of use
- (d) type of use (calibrations, routine measurements, etc.)
- (e) badge identification



## SECTION 7 - REFERENCE MATERIAL

7.1 General. An authorization for the use of radioactive material in the licensing jurisdiction of the USAEC requires that the user comply with the rules and regulations established by that Agency. The formal regulations issued to date are found in the Code of Federal Regulations, Title 10, parts 20 and 30. Portions of these regulations including those cited as references in this issuance, are included in the Supplement. Where needed copies of 10 CFR 20 and 30 will be furnished by the RSO upon request.

Pertinent excerpts from the regulations of the Food and Drug Administration which are applicable to certain provisions of these rules are given in the Supplement, Page 10.

Questions regarding the applicable regulations of the Interstate Commerce Commission, the Post Office Department, the Civil Aeronautics Administration, and the various States should be directed to the RSO.

7.2 NCRP. Recommendations of the National Committee on Radiation Protection to be found in the Handbooks of the National Bureau of Standards listed below will serve as guides in setting up laboratories and procedures. Handbooks 42, 48 and 51, at least, should be studied by all personnel working with radioisotopes. It is to be noted that these "Recommendations" have no official status and their use requires specific authorization.

- a. Handbook 42. Safe Handling of Radioactive Isotopes.
- b. Handbook 48. Control and Removal of Radioactive Contamination in Laboratories.
- c. Handbook 49. Recommendations for Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users.
- d. Handbook 50. X-ray Protection Design.



- e. Handbook 51. Radiological Monitoring Methods and Instruments.
- f. Handbook 52. Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water.
- g. Handbook 53. Recommendations for the Disposal of Carbon-14 Wastes.
- h. Handbook 54. Protection Against Radiations from Radium, Cobalt-60 and Cesium-137.
- i. Handbook 59. Permissible Dose from External Sources of Ionizing Radiation.

7.3 Miscellaneous Publications. Helpful material will be found in the following:

- a. "Survey and Monitoring of Radiation from Radioisotopes," Morgan, G. W., Nucleonics 4, 24-37 (1949)
- b. "Impact of Radioactivity on Chemical Laboratory Techniques and Design," Tompkins, P. C. and Levy, H. A., Ind. Eng. Chem. 41 228-231 (1949)
- c. "Remodeling a Laboratory for Radiochemical Instruction or Research," Levy, H. A., Ind. Eng. Chem. 41 248-250 (1949)
- d. "Radioisotope Laboratory Techniques," Faires, R. A. and Parks, B. H., George Newnes, Ltd. London (1958)
- e. "Radioisotopes in Agriculture and Biology," Comar, C. L., McGraw-Hill, Inc., (1955)

## SECTION 8 - SUPPLY OF FORMS

8.1 OA Form 2, Report of Receipt of Radioactive Materials, and OA Form 3, Radioactive Waste Disposal Report, will be furnished by the RSO.



OA Form 22, Personnel Radiation Exposure Report, and OA Form 23, Field and Greenhouse Experiments Monitoring Report, will be stocked in Central Supply and should be ordered through the usual channels.





## MEMBERSHIP OF RADIOLOGICAL

## SAFETY COMMITTEE

Chairman - H. L. Haller, Office of Administrator, ARS

F. H. Spencer, Office of Administrator, ARS

L. T. Alexander, Soil Survey, SCS

J. A. Beal, Division of Forest Insect  
Research, FS

S. B. Hendricks, Soil & Water Conservation  
Research Division, ARS

J. R. Matchett, Office of Administrator, ARS

W. T. Pentzer, Marketing Research Division,  
AMS

F. A. Todd, Office of Administrator, ARS

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Telephone Webster 5-4620, Ext. 345



## Part 20—Standards for Protection Against Radiation

\* \* \*

### PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

§ 20.101 *Exposure of individuals in restricted areas*—(a) *Exposure to radiation.* (1) Except as provided in subparagraph (2) of this paragraph, no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of seven consecutive days from radioactive material and other sources of radiation in the licensee's possession a dose in excess of the limits specified in Appendix A of this part.

(2) A licensee may permit an individual in a restricted area to receive a dose in excess of the limits established in subparagraph (1) of this paragraph: *Provided*, (i) That the dose during any period of 7 consecutive days does not exceed three times the limits specified in Appendix A of this part, and (ii) that the dose during any period of 13 consecutive weeks does not exceed 10 times the limits specified in Appendix A of this part.

(b) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual in a restricted area to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table I, of this part.

The limits given in Appendix B, Table I of this part, are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be increased proportionately. In any such period, where the number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

(c) *Exposure of minors.* No licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual under 18 years of age within a restricted area to receive in any period of seven consecutive days from radioactive material and other sources of radiation in the licensee's possession a dose in excess of 10 percent of the limits

specified in Appendix A of this part, or to be exposed to airborne radioactive material possessed by the licensee in a concentration in excess of the limits specified in Appendix B, Table II, of this part. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

§ 20.102 *Permissible levels of radiation in unrestricted areas.* (a) There may be included in any application for a license or for amendment of a license proposed limits upon levels of radiation in unrestricted areas resulting from the applicant's possession or use of radioactive material and other sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose in any period of seven consecutive days in excess of 10 percent of the limits specified in Appendix A of this part.

(b) Except as authorized by the Commission pursuant to paragraph (a) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to create in any unrestricted area from radioactive material and other sources of radiation in his possession:

(1) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour, or

(2) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

§ 20.103 *Concentrations in effluents to unrestricted areas.* (a) There may be included in any application for a license or for amendment of a license proposed limits upon concentrations of licensed and other radioactive material released into air or water in unrestricted areas as a result of the applicant's proposed activities. Such applications should include information as to anticipated average concentrations and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that it is not likely that any individual will be exposed to concentra-



tions in excess of the limits specified in Appendix B, Table II, of this part. For purposes of this paragraph, concentrations may be averaged over periods not greater than one year.

\* \* \*

§ 20.105 *Measures to be taken after excessive exposures.* In the event that any individual in a restricted area receives a dose or is exposed to concentrations of radioactive material in excess of the permissible limits established in § 20.101, the licensee shall limit the weekly dose or exposure of the individual to 10 percent of such permissible limit until such time as the average weekly dose or exposure to the individual for the period beginning with the week in which the excessive dose or exposure occurred is less than the permissible limit established in § 20.101.

#### PRECAUTIONARY PROCEDURES

§ 20.201 *Surveys.* (a) As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

(b) Each licensee shall make or cause to be made such surveys as may be necessary for him to comply with the regulations in this part.

§ 20.202 *Personnel monitoring.* (a) Each licensee shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(1) Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in excess of 25 percent of the limits specified in Appendix A of this part;

(2) Each individual who enters a high radiation area.

(b) As used in this part,

(1) "Personnel monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e. g., film badges, pocket chambers, pocket dosimeters, film rings, etc.);

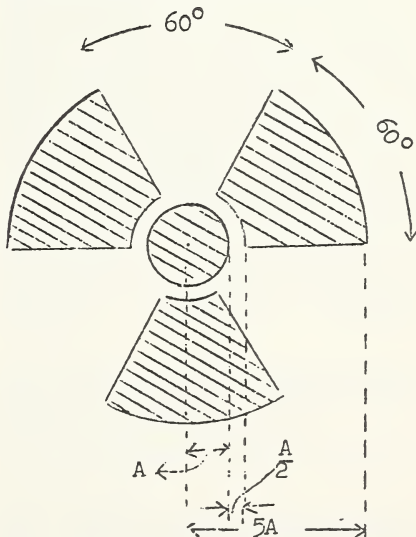
(2) "Radiation area" means any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 150 millirem;

(3) "High radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

§ 20.203 *Caution signs, labels, and signals—(a) General.* (1) Except as otherwise authorized by the Commission, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-bladed design:

#### RADIATION SYMBOL

1. Cross-hatched area is to be magenta or purple.
2. Background is to be yellow.



(2) In addition to the contents of signs and labels prescribed in this section, licensees may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation or to radioactive material.





\* \* \*

(e) *Additional requirements.* (1) Each area or room in which licensed material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in an amount exceeding 10 times the quantity of such material specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION<sup>1</sup>

RADIOACTIVE MATERIAL(S)

\* \* \*

(f) *Containers.* (1) Each container in which is transported, stored, or used a quantity of any licensed material (other than natural uranium or thorium) greater than the quantity of such material specified in Appendix C of this part shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION<sup>1</sup>

RADIOACTIVE MATERIAL

\* \* \*

(3) Notwithstanding the provisions of subparagraphs (1) and (2) a label shall not be required:

(i) If the concentration of the material in the container does not exceed that specified in Appendix B, Table I, Column 2 of this part, or

(ii) For laboratory containers, such as beakers, flasks, and test tubes, used transiently in laboratory procedures, when the user is present.

(4) Where containers are used for storage, the labels required in this paragraph shall state also the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

\* \* \*

§ 20.206 *Instruction of personnel.* All individuals working in or frequenting any portion of a restricted area shall be informed of the occurrence of radioactive materials or of radiation in such portion, and shall be instructed in the hazards of excessive exposure to such materials or radiation and in precautions or procedures to minimize exposure.

<sup>1</sup> Or "Danger."

§ 20.207 *Storage of licensed materials.* Licensed materials stored in an unrestricted area shall be secured against unauthorized removal from the place of storage.

## WASTE DISPOSAL

§ 20.301 *General requirement.* No licensee shall dispose of licensed material except:

(a) By transfer to an authorized recipient as provided in the regulations in Part 30, 40, or 70 of this chapter, which ever may be applicable; or

(b) As authorized pursuant to § 20.302; or

(c) As provided in § 20.303 or § 20.304, applicable respectively to the disposal of licensed material by release into sanitary sewerage systems or burial in soil, or in § 20.103 (Concentrations in Effluents to Unrestricted Areas).

§ 20.302 *Method for obtaining approval of proposed disposal procedures.* Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

§ 20.303 *Disposal by release into sanitary sewerage systems.* No licensee shall discharge licensed material into a sanitary sewerage system unless:

(a) It is readily soluble or dispersible in water; and

(b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of subparagraphs (1) or (2) of this paragraph:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration





equal to the limits specified in Appendix B, Table I, Column 2 of this part; or

\* \* \*

(2) Ten times the quantity of such material specified in Appendix C of this part; and

(c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix B, Table I, Column 2 of this part; and

(d) The gross quantity of licensed and other radioactive material released into the sewerage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

§ 20.304 *Disposal by burial in soil.* No licensee shall dispose of licensed material by burial in soil unless:

(a) The total quantity of licensed and other radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix C of this part; and

(b) Burial is at a minimum depth of four feet; and

(c) Successive burials are separated by distances of at least six feet and not more than 12 burials are made in any year.

§ 20.305 *Treatment or disposal by incineration.* No licensee shall treat or dispose of licensed material by incineration except as specifically approved by the Commission, pursuant to §§ 20.103 (a) and 20.307

#### RECORDS, REPORTS, AND NOTIFICATION

§ 20.401 *Records of surveys, radiation monitoring, and disposal.* (a) Each licensee shall maintain records showing the radiation exposures of all individuals subject to personnel monitoring control under § 20.202 of the regulations in this part.

(b) Each licensee shall maintain records showing the name of each individual exposed to radiation pursuant to § 20.101 (a) (2) and the weekly dose of each such individual for the 13 consecutive weeks of highest cumulative weekly dose.

(c) Each licensee shall maintain records in the same units used in the appendices to this part, showing the results of surveys required by § 20.201 (b), and disposals made under §§ 20.302, 20.303, and 20.304.



APPENDIX A  
PERMISSIBLE WEEKLY DOSE

Conditions of exposure		Dose in critical organs (mrem)			
Parts of body	Radiation	Skin, at basal layer of epidermis	Blood forming organs	Gonads	Lens of eye
Whole body.....	Any radiation with half-value-layer greater than 1 mm of soft tissue.	1 600	1 300	1 300	1 300 <sup>1</sup>
Whole body.....	Any radiation with half-value-layer less than 1 mm of soft tissue.	1,500	300	300	300
Hands and forearms or feet and ankles or head and neck.	Any radiation.....	2 1,500	-----	-----	-----

<sup>1</sup> For exposures of the whole body to X or gamma rays up to 3 mev, this condition may be assumed to be met if the "air dose" does not exceed 300 mr, provided the dose to the gonads does not exceed 300 mrem. "Air dose" means that the dose is measured by an appropriate instrument in air in the region of highest dosage rate to be occupied by an individual, without the presence of the human body or other absorbing and scattering material.

<sup>2</sup> Exposure of these limited portions of the body under these conditions does not alter the total weekly dose of 300 mrem permitted to the bloodforming organs in the main portion of the body, to the gonads, or to the lens of the eye.

APPENDIX B  
PERMISSIBLE CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

Material	Table I		Table II	
	Column 1 <sup>1</sup>	Column 2 <sup>2</sup>	Column 1 <sup>1</sup>	Column 2 <sup>2</sup>
	Air (2)	Water (3)	Air (2)	Water (3)
A <sup>41</sup> .....	1.6×10 <sup>-6</sup>	1.4×10 <sup>-3</sup>	5×10 <sup>-4</sup>	5×10 <sup>-6</sup>
Ag <sup>105</sup> .....	3.6×10 <sup>-5</sup>	5	1.2×10 <sup>-6</sup>	1.6×10 <sup>-1</sup>
Ag <sup>111</sup> .....	1×10 <sup>-4</sup>	13	3×10 <sup>-6</sup>	4×10 <sup>-1</sup>
Am <sup>241</sup> .....	8×10 <sup>-11</sup>	4×10 <sup>-4</sup>	3×10 <sup>-12</sup>	1.3×10 <sup>-5</sup>
As <sup>76</sup> .....	7×10 <sup>-6</sup>	6×10 <sup>-1</sup>	2×10 <sup>-7</sup>	2×10 <sup>-3</sup>
At <sup>211</sup> .....	9×10 <sup>-10</sup>	6×10 <sup>-6</sup>	3×10 <sup>-11</sup>	2×10 <sup>-7</sup>
Au <sup>195</sup> .....	3.4×10 <sup>-7</sup>	9×10 <sup>-3</sup>	1.1×10 <sup>-8</sup>	3×10 <sup>-4</sup>
Au <sup>198</sup> .....	8×10 <sup>-7</sup>	2×10 <sup>-2</sup>	2.5×10 <sup>-8</sup>	7×10 <sup>-4</sup>
Ba <sup>140</sup> +La <sup>140</sup> .....	2×10 <sup>-7</sup>	6×10 <sup>-3</sup>	6×10 <sup>-9</sup>	2×10 <sup>-4</sup>
Be <sup>7</sup> .....	1.3×10 <sup>-5</sup>	3	4×10 <sup>-7</sup>	1×10 <sup>-1</sup>
C <sup>14</sup> .....	1.4×10 <sup>-8</sup>	1×10 <sup>-2</sup>	5×10 <sup>-8</sup>	3.6×10 <sup>-4</sup>
Ca <sup>45</sup> .....	9×10 <sup>-8</sup>	1.5×10 <sup>-3</sup>	3×10 <sup>-9</sup>	5×10 <sup>-3</sup>
Cd <sup>109</sup> +Ag <sup>109</sup> .....	2×10 <sup>-7</sup>	2×10 <sup>-1</sup>	7×10 <sup>-9</sup>	7×10 <sup>-3</sup>
Ce <sup>144</sup> +Pr <sup>144</sup> .....	2×10 <sup>-5</sup>	1×10 <sup>-1</sup>	7×10 <sup>-10</sup>	3.6×10 <sup>-3</sup>
Cl <sup>36</sup> .....	1×10 <sup>-6</sup>	7×10 <sup>-3</sup>	4×10 <sup>-8</sup>	2.4×10 <sup>-4</sup>
Cm <sup>242</sup> .....	5×10 <sup>-10</sup>	2.7×10 <sup>-3</sup>	1.8×10 <sup>-11</sup>	1×10 <sup>-1</sup>
Co <sup>60</sup> .....	3.4×10 <sup>-6</sup>	5×10 <sup>-2</sup>	1.2×10 <sup>-7</sup>	1.8×10 <sup>-3</sup>
Cr <sup>51</sup> .....	2.4×10 <sup>-5</sup>	1.4	8×10 <sup>-7</sup>	5×10 <sup>-2</sup>
Cs <sup>137</sup> +Ba <sup>137</sup> .....	6×10 <sup>-7</sup>	4.5×10 <sup>-3</sup>	2×10 <sup>-8</sup>	1.5×10 <sup>-4</sup>
Cu <sup>64</sup> .....	2×10 <sup>-7</sup>	2.5×10 <sup>-1</sup>	6×10 <sup>-7</sup>	8×10 <sup>-3</sup>
Eu <sup>154</sup> .....	2×10 <sup>-8</sup>	1×10 <sup>-1</sup>	6×10 <sup>-10</sup>	3×10 <sup>-3</sup>
Fe <sup>58</sup> .....	3.5×10 <sup>-4</sup>	2.6	1.2×10 <sup>-5</sup>	9×10 <sup>-2</sup>
Fe <sup>59</sup> .....	1.8×10 <sup>-6</sup>	1.3×10 <sup>-2</sup>	6×10 <sup>-8</sup>	4×10 <sup>-4</sup>
Fe <sup>56</sup> .....	5×10 <sup>-9</sup>	3.3×10 <sup>-4</sup>	1.5×10 <sup>-9</sup>	1.1×10 <sup>-5</sup>
Ga <sup>72</sup> .....	1×10 <sup>-5</sup>	26	3.4×10 <sup>-7</sup>	9×10 <sup>-1</sup>
Ge <sup>71</sup> .....	1×10 <sup>-4</sup>	27	3.6×10 <sup>-6</sup>	9×10 <sup>-1</sup>
H <sup>3</sup> (HTO or T <sub>2</sub> O).....	7×10 <sup>-5</sup>	5×10 <sup>-1</sup>	2.5×10 <sup>-6</sup>	1.6×10 <sup>-3</sup>
Hol <sup>166</sup> .....	1×10 <sup>-5</sup>	70	3×10 <sup>-7</sup>	2.3
I <sup>131</sup> .....	9×10 <sup>-9</sup>	9×10 <sup>-6</sup>	3×10 <sup>-10</sup>	3×10 <sup>-4</sup>
Ir <sup>190</sup> .....	2.2×10 <sup>-6</sup>	4×10 <sup>-2</sup>	7×10 <sup>-8</sup>	1.3×10 <sup>-3</sup>
Ir <sup>192</sup> .....	1.5×10 <sup>-7</sup>	2.7×10 <sup>-3</sup>	5×10 <sup>-9</sup>	9×10 <sup>-3</sup>
K <sup>42</sup> .....	6×10 <sup>-6</sup>	4×10 <sup>-2</sup>	2×10 <sup>-7</sup>	1.4×10 <sup>-3</sup>
La <sup>138</sup> .....	4×10 <sup>-6</sup>	3.4	1.4×10 <sup>-7</sup>	1.1×10 <sup>-1</sup>
Lu <sup>177</sup> .....	1.5×10 <sup>-10</sup>	70	5×10 <sup>-7</sup>	2.4
Mn <sup>56</sup> .....	8×10 <sup>-6</sup>	5×10 <sup>-1</sup>	3×10 <sup>-7</sup>	1.5×10 <sup>-3</sup>
Mo <sup>99</sup> .....	5×10 <sup>-5</sup>	40	1.8×10 <sup>-4</sup>	1.4
Na <sup>24</sup> .....	5×10 <sup>-6</sup>	2.4×10 <sup>-2</sup>	1.6×10 <sup>-7</sup>	8×10 <sup>-4</sup>
Nb <sup>94</sup> .....	1.3×10 <sup>-6</sup>	1.2×10 <sup>-2</sup>	4×10 <sup>-8</sup>	4×10 <sup>-4</sup>
Ni <sup>59</sup> .....	5×10 <sup>-5</sup>	7×10 <sup>-1</sup>	1.6×10 <sup>-6</sup>	2.5×10 <sup>-3</sup>
P <sup>32</sup> .....	4×10 <sup>-7</sup>	6×10 <sup>-4</sup>	1.4×10 <sup>-8</sup>	2×10 <sup>-5</sup>
Pb <sup>203</sup> .....	2×10 <sup>-5</sup>	4×10 <sup>-1</sup>	6×10 <sup>-7</sup>	1.4×10 <sup>-3</sup>
Pb <sup>103</sup> +Rh <sup>103</sup> .....	2×10 <sup>-6</sup>	2×10 <sup>-2</sup>	7×10 <sup>-8</sup>	1×10 <sup>-3</sup>
Pm <sup>147</sup> .....	6×10 <sup>-7</sup>	3	2×10 <sup>-8</sup>	1×10 <sup>-1</sup>

See footnotes at end of table.



## APPENDIX B—Continued

## PERMISSIBLE CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

Material	Table I		Table II	
	Column 1 <sup>1</sup>	Column 2 <sup>2</sup>	Column 1 <sup>1</sup>	Column 2 <sup>2</sup>
	Air (2)	Water (3)	Air (2)	Water (3)
Po <sup>210</sup> (soluble).....	6×10 <sup>-10</sup>	9×10 <sup>-5</sup>	2×10 <sup>-11</sup>	3×10 <sup>-6</sup>
Po <sup>210</sup> (insoluble).....	2×10 <sup>-10</sup>	-----	7×10 <sup>-12</sup>	-----
Pr <sup>143</sup> .....	2.3×10 <sup>-6</sup>	1	7×10 <sup>-5</sup>	3.6×10 <sup>-2</sup>
Pu <sup>239</sup> (soluble).....	6×10 <sup>-12</sup>	4.5×10 <sup>-5</sup>	2×10 <sup>-12</sup>	1.5×10 <sup>-7</sup>
Pu <sup>239</sup> (insoluble).....	6×10 <sup>-12</sup>	-----	2×10 <sup>-12</sup>	-----
Ra <sup>226</sup> +1/2 dr.....	2.4×10 <sup>-11</sup>	1.2×10 <sup>-7</sup>	8×10 <sup>-12</sup>	4×10 <sup>-9</sup>
Rb <sup>85</sup> .....	1.1×10 <sup>-6</sup>	9×10 <sup>-3</sup>	4×10 <sup>-8</sup>	3×10 <sup>-4</sup>
Re <sup>185</sup> .....	2.4×10 <sup>-5</sup>	2.4×10 <sup>-1</sup>	8×10 <sup>-7</sup>	8×10 <sup>-3</sup>
Rh <sup>105</sup> .....	3×10 <sup>-6</sup>	5×10 <sup>-2</sup>	1×10 <sup>-7</sup>	1.6×10 <sup>-3</sup>
Rh <sup>222</sup> +dr.....	1×10 <sup>-7</sup>	6×10 <sup>-6</sup>	3.3×10 <sup>-9</sup>	2×10 <sup>-7</sup>
Ru <sup>106</sup> +Rh <sup>106</sup> .....	8×10 <sup>-8</sup>	4×10 <sup>-1</sup>	2.6×10 <sup>-9</sup>	1.3×10 <sup>-2</sup>
S <sup>32</sup> .....	3×10 <sup>-6</sup>	1.5×10 <sup>-2</sup>	1×10 <sup>-7</sup>	5×10 <sup>-4</sup>
Sc <sup>46</sup> .....	2×10 <sup>-7</sup>	1	7×10 <sup>-9</sup>	3.6×10 <sup>-2</sup>
Sm <sup>151</sup> .....	4×10 <sup>-8</sup>	6×10 <sup>-1</sup>	1.3×10 <sup>-9</sup>	2×10 <sup>-2</sup>
Sn <sup>115</sup> .....	1.7×10 <sup>-6</sup>	5×10 <sup>-1</sup>	6×10 <sup>-3</sup>	1.6×10 <sup>-2</sup>
Sr <sup>89</sup> .....	6×10 <sup>-9</sup>	2×10 <sup>-4</sup>	2×10 <sup>-9</sup>	7×10 <sup>-3</sup>
Sr <sup>90</sup> +Y <sup>90</sup> .....	6×10 <sup>-10</sup>	2.4×10 <sup>-6</sup>	2×10 <sup>-11</sup>	8×10 <sup>-3</sup>
Te <sup>130</sup> .....	8×10 <sup>-6</sup>	8×10 <sup>-2</sup>	3×10 <sup>-7</sup>	3×10 <sup>-3</sup>
Te <sup>127</sup> .....	3×10 <sup>-7</sup>	8×10 <sup>-2</sup>	1×10 <sup>-9</sup>	3×10 <sup>-3</sup>
Te <sup>129</sup> .....	1.2×10 <sup>-7</sup>	3.3×10 <sup>-2</sup>	4×10 <sup>-9</sup>	1.1×10 <sup>-3</sup>
Th <sup>232</sup> .....	2×10 <sup>-6</sup>	10	6×10 <sup>-9</sup>	3×10 <sup>-1</sup>
Th-natural (soluble).....	5×10 <sup>-11</sup>	1.5×10 <sup>-6</sup>	1.7×10 <sup>-12</sup>	5×10 <sup>-3</sup>
Th-natural (insoluble).....	5×10 <sup>-11</sup>	-----	1.7×10 <sup>-12</sup>	-----
Ti <sup>102</sup> .....	1.5×10 <sup>-7</sup>	8×10 <sup>-2</sup>	5×10 <sup>-4</sup>	2.5×10 <sup>-2</sup>
U-natural (soluble) <sup>1</sup> .....	5×10 <sup>-11</sup>	2×10 <sup>-4</sup>	1.7×10 <sup>-12</sup>	7×10 <sup>-6</sup>
U-natural (insoluble) <sup>1</sup> .....	5×10 <sup>-11</sup>	-----	1.7×10 <sup>-12</sup>	-----
U <sup>233</sup> (soluble).....	4×10 <sup>-10</sup>	4.5×10 <sup>-4</sup>	1×10 <sup>-11</sup>	1.5×10 <sup>-5</sup>
U <sup>233</sup> (insoluble).....	5×10 <sup>-11</sup>	-----	1.6×10 <sup>-12</sup>	-----
V <sup>48</sup> .....	3×10 <sup>-6</sup>	1.5	1×10 <sup>-7</sup>	5×10 <sup>-2</sup>
Xe <sup>133</sup> .....	1.3×10 <sup>-5</sup>	1.3×10 <sup>-2</sup>	4×10 <sup>-7</sup>	4×10 <sup>-4</sup>
Xe <sup>135</sup> .....	5×10 <sup>-5</sup>	4×10 <sup>-3</sup>	1.7×10 <sup>-7</sup>	1.4×10 <sup>-4</sup>
Y <sup>91</sup> .....	1.2×10 <sup>-7</sup>	6×10 <sup>-1</sup>	4×10 <sup>-9</sup>	2×10 <sup>-3</sup>
Zn <sup>65</sup> .....	6×10 <sup>-5</sup>	2×10 <sup>-1</sup>	2×10 <sup>-7</sup>	6×10 <sup>-3</sup>
Unidentified beta or gamma emitters or any undetermined mixtures of beta or gamma emitters.....	-----	-----	1×10 <sup>-9</sup>	1×10 <sup>-7</sup>
Unidentified alpha emitters or any undetermined mixtures of alpha emitters.....	-----	-----	9×10 <sup>-12</sup>	1×10 <sup>-7</sup>

<sup>1</sup> Air concentrations are given in microcuries per milliliter of air.<sup>2</sup> Water concentrations are given in microcuries per milliliter of water. These figures also apply to foodstuffs in microcuries per gram (wet-weight).<sup>3</sup> For enriched uranium the same radioactivities per unit volume as those for natural uranium are applicable. It should be noted that the contribution of U-234 to the gross activity of enriched uranium is 20-40 times that of the U-235.

## APPENDIX C

Material	Microcuries
Ag <sup>105</sup> .....	1
Ag <sup>111</sup> .....	10
As <sup>76</sup> , As <sup>77</sup> .....	10
Au <sup>198</sup> .....	10
Au <sup>199</sup> .....	10
Ba <sup>140</sup> +La <sup>140</sup> .....	1
Be <sup>7</sup> .....	50
C <sup>14</sup> .....	50
Ca <sup>45</sup> .....	10
Cd <sup>109</sup> +Ag <sup>109</sup> .....	10
Ce <sup>144</sup> +Pr <sup>144</sup> .....	1
Ci <sup>135</sup> .....	1
Co <sup>60</sup> .....	1
Cr <sup>51</sup> .....	50
Cs <sup>137</sup> +Ba <sup>137</sup> .....	1
Cu <sup>64</sup> .....	50
Eu <sup>154</sup> .....	1
F <sup>18</sup> .....	50
Fe <sup>55</sup> .....	50
Fe <sup>59</sup> .....	1
Ga <sup>72</sup> .....	10
Ge <sup>71</sup> .....	50
H <sup>3</sup> (HTO or H <sub>2</sub> O).....	250

## APPENDIX C—Continued

Material	Microcuries
I <sup>131</sup> .....	10
In <sup>114</sup> .....	1
Ir <sup>192</sup> .....	10
K <sup>42</sup> .....	10
La <sup>140</sup> .....	10
Mn <sup>52</sup> .....	1
Mn <sup>56</sup> .....	50
Mo <sup>99</sup> .....	10
Na <sup>22</sup> .....	10
Na <sup>24</sup> .....	10
Nb <sup>95</sup> .....	10
Ni <sup>59</sup> .....	1
Ni <sup>63</sup> .....	1
P <sup>32</sup> .....	10
Pd <sup>103</sup> +Rh <sup>103</sup> .....	50
Pd <sup>109</sup> .....	10
Pm <sup>147</sup> .....	10
Po <sup>210</sup> .....	0.1
Pr <sup>143</sup> .....	10
Pu <sup>239</sup> .....	1
Ra <sup>226</sup> .....	0.1
Rb <sup>86</sup> .....	10
Re <sup>186</sup> .....	10



## APPENDIX C—Continued

Material	Micro-curies
Rh <sup>108</sup> .....	10
Ru <sup>106</sup> +Rh <sup>106</sup> .....	1
S <sup>35</sup> .....	50
Sb <sup>124</sup> .....	1
Sc <sup>45</sup> .....	1
Sm <sup>153</sup> .....	10
Sn <sup>119</sup> .....	10
Sp <sup>99</sup> .....	1
Sp <sup>99</sup> +Y <sup>90</sup> .....	0.1
Ta <sup>182</sup> .....	10
Tc <sup>99</sup> .....	1
Tc <sup>99</sup> .....	1
Te <sup>127</sup> .....	10
Te <sup>129</sup> .....	1
Th (natural).....	50
Ti <sup>204</sup> .....	50
Tritium. See H <sup>3</sup> .....	250
U (natural).....	50
U <sup>233</sup> .....	1
U <sup>234</sup> -U <sup>235</sup> .....	50
V <sup>48</sup> .....	1
W <sup>185</sup> .....	10
Y <sup>90</sup> .....	1
Y <sup>91</sup> .....	1
Zn <sup>65</sup> .....	10
Unidentified radioactive materials or any of the above, in unknown mixtures.....	0.1

NOTE: For purposes of §§ 20.203 and 20.304, where there is involved a combination of isotopes in known amounts the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i. e., "unity").

EXAMPLE: For purposes of § 20.304, if a particular batch contains 2,000  $\mu\text{c}$  of Au<sup>198</sup> and 25,000  $\mu\text{c}$  of C<sup>14</sup>, it may also include not more than 3,000  $\mu\text{c}$  of I<sup>131</sup>. This limit was determined as follows:

$$\frac{2,000 \mu\text{c Au}^{198}}{10,000 \mu\text{c}} + \frac{25,000 \mu\text{c C}^{14}}{50,000 \mu\text{c}} + \frac{3,000 \mu\text{c I}^{131}}{10,000 \mu\text{c}} = 1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1000 as provided in § 20.304.





**Part 30—Licensing of Byproduct Material**

\* \* \*

**GENERAL LICENSES; APPLICATIONS FOR LICENSES**

\* \* \*

§ 30.23 *General requirements for issuance of specific licenses.* An application for a specific license will be approved if:

(a) The application is for a purpose authorized by the act; and

(b) The applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life or property; and

(c) The applicant is qualified by training and experience to use the material for the purpose requested in such manner as to protect health and minimize danger to life or property; and

(d) The applicant satisfies any applicable special requirements contained in § 30.24.

§ 30.24 *Special requirements for issuance of specific licenses—*

\* \* \*

(d) *Multiple quantities or types of byproduct material for use in research and development.* An application for a specific license for multiple quantities or types of byproduct material for use in research and development will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant has received a reasonable number of licenses for a variety of radioisotopes for a variety of research and development uses; and

(3) The applicant has established an isotope committee (composed of such persons as a radiological safety officer, a representative of the business office, and one or more persons trained or experienced in the safe use of radioactive materials) which will review and approve, in advance of purchase of radioisotopes, proposals for such uses; and

(4) The applicant has appointed a radiological safety officer who will advise on or be available for advice and assistance on radiological safety problems.

(e) *Multiple quantities or types of byproduct material for use in processing.* An application for a specific license for multiple quantities or types of byproduct material for use in processing for distribution to other authorized persons will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant has received a reasonable number of licenses for processing and distribution of a variety of radioisotopes; and

(3) The applicant has appointed a radiological safety officer who will advise on or be available for advice and assistance on radiological safety problems.

**LICENSES**

§ 30.31 *Issuance of specific licenses for use of byproduct material.* (a) Upon a determination that an application meets the requirements of the Act and the regulations of the Commission, the Commission will issue a specific license authorizing the possession and use of byproduct material (Form AEC 374, "Byproduct Material License").

(b) The Commission may incorporate in any license at the time of issuance, or thereafter by appropriate rule, regulation or order, such additional requirements and conditions with respect to the licensee's receipt, possession, use and transfer of byproduct material as it deems appropriate or necessary in order to:

(1) Promote the common defense and security;

(2) Protect health or to minimize danger to life or property;

(3) Protect restricted data;

(4) Require such reports and the keeping of such records, and to provide for such inspections of activities under the license as may be necessary or appropriate to effectuate the purposes of the act and regulations thereunder.

§ 30.32 *Terms and conditions of licenses.* (a) Each license issued pursuant to the regulations in this part shall be subject to all the provisions of the act, now or hereafter in effect, and to all valid rules, regulations and orders of the Commission.

(b) Neither the license nor any right under the license shall be assigned or otherwise transferred in violation of the provisions of the act.

(c) Each person licensed by the Commission pursuant to the regulations in this part shall confine his possession and



use of byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to the regulations in this part shall carry with it the right to receive, acquire, own, possess and import byproduct material and to transfer such material to other licensees within the United States authorized to receive such material.

(d) Each license issued pursuant to the regulations in this part shall be deemed to contain the provisions set forth in section 183a.-d., inclusive, of the act, whether or not said provisions are expressly set forth in the license.

\* \* \*

#### RECORDS, REPORTS AND INSPECTIONS

§ 30.41 *Records.* (a) Each person who receives byproduct material pursuant to a license issued pursuant to the regulations in this part shall keep records showing the receipt, transfer, export and disposal of such byproduct material.

\* \* \*

§ 30.43 *Inspection.* (a) Each licensee shall afford to the Commission at all reasonable times opportunity to inspect byproduct material and the premises and facilities wherein byproduct material is used or stored.

(b) Each licensee shall make available to the Commission for inspection, upon reasonable notice, records kept by him pursuant to the regulations in this chapter.

§ 30.44 *Tests.* Each licensee shall perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part, including tests of:

- (a) Byproduct material,
- (b) Facilities wherein byproduct material is utilized or stored,
- (c) Radiation detection and monitoring instruments, and
- (d) Other equipment and devices used in connection with the utilization or storage of byproduct material.



## Excerpt from

FEDERAL FOOD, DRUG AND COSMETIC ACT, JUNE 1958.

The use of plants, plant products and animal products, such as alfalfa, silage, meat, milk, as food or feed, is specifically prohibited by the Federal Food, Drug and Cosmetic Act if radiation or radioisotopes have been used in their production or processing.

This case is considered as falling under the "poisons per se" clause as well as being included under the Foods Additive Amendment of 1958, Section 2, 201 and Section 3, 402.

7/1/59



U. S. DEPARTMENT OF AGRICULTURE		1. AGENCY	
<b>REPORT OF RECEIPT OF RADIOACTIVE MATERIALS</b>		2. DIVISION, BRANCH AND SECTION	
INSTRUCTIONS: Complete in duplicate within two days after opening of shipment. Forward original to Radiological Safety Officer, Radiological Safety Committee, Plant Industry Station, Beltsville, Maryland.		3. ADDRESS	
SECTION A - SHIPMENT			
1. RADIOLOGICAL SAFETY COMM. IDENTIFICATION		2. LICENSE NUMBER	3. PURCHASE ORDER NUMBER
4. DATE RECEIVED	5. DATE OPENED	6. ISOTOPE	7. QUANTITY (mc)
8. CHEMICAL FORM			9. SPECIFIC ACTIVITY
SECTION B - SURVEY			
1. INSTRUMENT USED			
2. CALIBRATION		3. BACKGROUND	
CPM                      MR/HR                      CPS			
4. READING FROM PACKAGES BEFORE OPENING (Distance)		5. READING FROM MATERIAL AFTER REMOVAL FROM PACKAGES (Distance)	
6. READING FROM STORAGE AREA AFTER ISOTOPE IS STORED (Distance)		7. READING AT NEAREST ROUTINE APPROACH TO STORAGE AREA (Distance)	
8. MAXIMUM READING DURING TRANSFER FROM CONTAINER TO STORAGE			
9. TIME REQUIRED FOR TRANSFER			
10. COMMENTS			
11. TITLE		12. SIGNATURE	13. DATE

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U. S. DEPARTMENT OF AGRICULTURE RADIOACTIVE WASTE DISPOSAL REPORT		1. AGENCY
INSTRUCTIONS: Complete in duplicate. Forward original upon completion of each experiment to the Radiological Safety Officer, Radiological Safety Committee, Plant Industry Station, Beltsville, Maryland.		2. DIVISION, BRANCH AND SECTION
		3. ADDRESS
4. RADIOLOGICAL SAFETY COMM. IDENTIFICATION	5. LICENSE NUMBER	6. PURCHASE ORDER NUMBER
7. ELEMENT AND ISOTOPE		
8. QUANTITY AND FORM (Show original quantity applied, or total used - list all forms of waste)		
9. OBSERVED RADIATION LEVEL OF WASTE-MAXIMUM (Indicate container type and distance)		
10. SITE OF EXPERIMENT		
11. DATE INITIATED	12. DATE TERMINATED	
13. DISPOSAL METHOD		
14. DISPOSAL SITE		
15. TITLE	16. SIGNATURE	17. DATE

OA Form 3  
Mar 1959

7/1/59



U. S. DEPARTMENT OF AGRICULTURE <b>FIELD AND GREENHOUSE EXPERIMENTS          MONITORING REPORT</b>		EXPERIMENT IDENTIFICATION AND SITE	
INSTRUCTIONS: Complete in duplicate for each material, at maximum rate of applications for each crop and each method of application. Forward original to the Radiological Safety Officer, Plant Industry Station, Beltsville, Maryland.		RADIOLOGICAL SAFETY COMMITTEE IDENTIFICATION	
SECTION A - SHIPMENT			
1. KIND OF MATERIAL	2. AMOUNT	3. ACTIVITY	4. DATE RECEIVED
PLANTING			
6. DATE		7. METHOD	
8. PERSONNEL WEARS (Check items used) <input type="checkbox"/> PROTECTIVE CLOTHING <input type="checkbox"/> RESPIRATOR <input type="checkbox"/> GLOVES <input type="checkbox"/> SHOE COVER <input type="checkbox"/> PERSONNEL METER <input type="checkbox"/> OTHER (Specify)			
MAXIMUM LEVEL WORKING DISTANCE FROM BELT OR HOPPER OF MACHINE 9A. UNCOVERED		10. MAXIMUM LEVEL APPROXIMATELY 2" ABOVE SURFACE AFTER PLANTING 11. BACKGROUND RATE - APPROXIMATELY 2" ABOVE SURFACE AFTER PLANTING (Use inactive plot or similarly prepared ground.)	
9B. COVERED			
EQUIPMENT SURVEY (Monitor field equipment carefully; clean at the site in restricted area if possible.) 12A. MAXIMUM LEVEL BEFORE CLEANING		13. INSTRUMENT USED 14. CALIBRATION	
12B. MAXIMUM LEVEL AFTER CLEANING		CPM      MR/HR	
SECTION B - FIELD SURVEY			
(Considerable latitude is permitted in actual time and procedures of survey.)			
1ST SURVEY METER READING (Early, within 10 days to 2 wks. Maximum observed at plant height, 1" from plant.) 1A. NUMBER OF DAYS AFTER PLANTING		2ND SURVEY METER READING (Same as Item 1, but made at that period when maximum uptake from applied fertilizer is expected.) 2A. NUMBER OF DAYS AFTER PLANTING	
1B. METER READING		2B. PLANT HEIGHT	
		2C. WEED HEIGHT	
3. THINNING OR SAMPLE HARVESTS (Note occasion and level)			
SECTION C - REMARKS			
FINAL HARVEST METER READING      STORAGE METER READING 4A. PLANT HEIGHT      4B. WEED HEIGHT      5A. SURFACE OF TYPICAL CONTAINER      5B. GENERAL LEVEL IN STORAGE AREA 6. WASTE <input type="checkbox"/> HELD FOR DECAY <input type="checkbox"/> OTHER (Give details in Section "C")			
1. TITLE		2. SIGNATURE	
3. DATE			













